The synopsis of the proposed research work entitled

Studies on Gamma ray interactions with High Density polymers for Gamma energies 123kev to 133kev

Submitted to

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To be submitted by

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For the registration of the degree
Doctor of Philosophy

In Physics

(Faculty of Science and Technology)

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Format for submission of PhD synopsis/

Work plan for faculty of science to be submitted in front of RRC.

Tittle: Studies on Gamma ray interaction with high density polymers for gamma energies 123kev to 133kev.

Abstract of proposed work plan:

In the present work, we determined the gamma-ray attenuation characteristics of different polymers using transmission geometry utilizing the NaI(Tl) scintillation detector and different radioactive sources in the energy range 123kev to 133kev. The experimental linear attenuation coefficient values are compared with theoretical data (J.H. Hubbell). The linear attenuation coefficient of all polymers reduced quickly with the increase in energy, at the beginning, while decrease more slowly in the region from 87keV to 123ke. The liner attenuation coefficient were obtain of the prepared samples through graphic representation of natural algorithm count rate as a function of the thickness of absorbent material the obtained data are presented in the form of gamma spectra behind the prepared samples. Linear attenuation coefficients (μ) gamma rays were calculate.

1]. Introduction:

When Gamma rays interact with matter, these can be either absorbed completely or scattered either by an electron or a nucleus through number of processes. Many of these processes are quite infrequent and some have yet not been observed. In the energy domain 123 to 133 KeV, gamma rays interrelate with matter primarily through three processes namely; Photoelectric effect, Compton Effect and Pair production. The amount of particular type of interaction probably depends upon incident photon energy, scattering angle, nature of the target material and experimental conditions.

Recently, various researches were concentrated on finding suitable shielding materials from high energy electromagnetic_radiation. These shielding materials are used for a variety of radiologic applications in medicine, industries, agriculture, nuclear reactors technologies. However, polymers can play a significant function in primary and secondary protection against neutral radiation such as gamma ray. Smart polymers can be defined as polymers material that undergo reversible large changes responding to small changes in the environment conditions such as electric and magnetic field, temperature, pH, the intensity of light, ionic factors and mechanical stress . Smart polymers are also known as intelligent

polymers since small changes happens in response to an external trigger until a critical point is reached, and these polymers have the capability to return to their first shape when trigger is removed.

There are many types of smart polymers such as Stimuli-responsive polymers, Temperature-responsive polymers, pH-responsive polymers, bio-responsive polymers, field-responsive polymers …etc.

The versatility and potential of smart polymers make them important for biomedical applications, tissue engineering applications, drug and gene delivery applications, aerospace industry and optical data storage industry.

Some common terms highlights on introduction:

Gamma ray: High energy electromagnetic radiation typically emitted from the atomic nucleus during nuclear decay processes.

X-ray: Fundamentally the same as gamma rays, but originating from electrons outside the atomic nucleus. Some resources may also distinguish gamma rays and x-rays based on energy.

Photon: An elementary particle of electromagnetic radiation.

Intensity or Flux: The number of photons detected or emitted over a time period.

Electron volt (ev): Unit of energy of gamma or x-ray photons, equal to 1.60 x 10-19 joules. More often expressed as 1,000 eV = **KeV** or 1,000,000 eV = **MeV**.

Photo peak: Peak observed in gamma ray spectrometry resulting from the deposition of the entire energy of the gamma photon within the detector. The energy or energies of the gamma ray photo peak(s) for particular radionuclide can be used to identify the radionuclide. For example, Co-60 emits gamma ray photons with photo peaks at 1173 and 1333 keV.3

Primary Radiation: Similar to photo peak. Source radiation or radiation which passes through the shielding material without its energy diminished through any scattering interactions.

Secondary Radiation: Also referred to as scattered radiation. Radiation which passes through the shielding material at diminished energy after undergoing scattering interaction(s) or is produced as a byproduct of scattering or absorption of radiation

Photoelectric effect: The complete transfer of energy from a gamma ray photon to an atomic electron of the shielding material. Photoelectric absorption is more common for lower energy gamma radiation (<500 keV) and for shielding materials constructed from high atomic number elements, such as tungsten, lead and bismuth.

Compton scattering: The transfer of part of the energy of a gamma ray photon to an atomic electron of the shielding material. After undergoing Compton scattering, the gamma photon may undergo further scattering or absorption interactions with the shielding material and/or emerge from the shielding material with diminished energy. Compton scattering is predominant at relatively high gamma energies (500-1500 keV) and for shielding constructed from low atomic weight materials (H2O, Al, Fe).

Pair production: An interaction of a gamma ray photon with the nucleus of an atom which results in the creation of beta particle and a positron. The positron then undergoes an annihilation reaction with an electron to produce two 511 keV gamma rays. The incident gamma radiation must have a minimum energy of 1022 keV to undergo pair production. Pair production becomes an important attenuation interaction for very high energy radiation (>1500 keV).

Attenuation coefficient: A quantity that characterizes how easily electromagnetic radiation penetrates a material. The attenuation coefficient is often expressed in terms of unit area per mass (cm2/g). The attenuation coefficient and the material density can be used to estimate the transmission of gamma radiation through a chosen thickness of shielding material or the thickness of a shielding material required to achieve a desired level of attenuation. Gamma attenuation coefficients are inversely dependent on gamma energy and directly proportional to the atomic number of the element(s) from which the shielding material is constructed.

2]. Review of literature and development in the subject (previous work done in the relevant area):

Gamma-ray which is used widely in medical care , electricity generation, and industry, it's the most penetrating of ionizing radiation that is known to be harmful to human health The shielding for radiation purposes are based on the type and energy of the radiation itself. Therefore, high density materials are used to protect life from Gamma hazardous radiation]. Lead bricks or high density concrete are often used. In addition, other metallic shields include copper, bismuth, tungsten, steel etc.

However lead is an excellent choice over all these shielding materials because of its higher atomic number, density, and low cost. However, lead is toxic and aprons are so heavy for personal shielding, Materials which are environment friendly, nontoxic and a polymer based can be used with both personal and material lighter shield. Recently, there was a continuous demand for improved polymers for use as shielding materials.

Polymers are inefficient to stop gamma rays on their own. So compound material filled with radio peak powder is now becoming more and more popular. Nowadays, researchers are generally studying various polymers and high density metals for radiation protection, in (2009) Harish, et al. Had been used unsaturated polyester resin as matrix material and used lead (II) oxide as filler. They found linear attenuation coefficient of the composite with 50% filler amount as 0.206 cm-1. Thus they reported that their composite's attenuation performance was better than cement, copper and silver. In (2011) Shafik,S,S . et al. had been studied the linear absorption factor for gamma rays were studied in shields from epoxy reinforced by lead powder and by aluminum powder, for NaI(Tl) scintillation detector using two radioactive sources (Co-60 and Cs-137).

The experimental results showed that the linear absorption facto increased with increasing the concentration for the powders and decreased with increasing thickness of the shields. In 2012 K.H.Mahdi et al. had been studied attenuation Coefficients for particulate Al, Fe, and Pb with different weight percentages(10,20,30,40,50)wt % reinforced unsaturated polyester resin . The results show the attenuation coefficients will increase as the concentration of particulate increased while it decreases when the gamma energy increase in (2013).

Dhameer A. Mutlak and Ahmed .H. Ali had been studied the properties of gamma shielding by using epoxy /lead powder and lead shut composite and found linear absorption caffeine. In (2014) E. ErenBelgin et al. had been studied A Novel Metal Oxide Filled Polyethylene Based Composite Shielding Material for Protection from Harmful Effects of Ionizing Electromagnetic Radiation. In (2015) Le Changet al had been studied the preparation and characterization of tungsten/epoxy composite for γ-rays radiation shielding.

In (2016) AL fakhar .M, et al., had been measured experimentally and calculated for both pure silicone, and silicone supported with lead. Two sizes of lead particles have been used the gamma radiation source have been used 137Cs.The results showed that the attenuation coefficient of silicone with lead additive is greater than the attenuation coefficient of silicone alone. In 2017 Najwa .J. Jubier had been studied the linear attenuation coefficient for particulate reinforced polymer- based composites. Unsaturated polyester resin (UPE) was used as matrix filled with (10wt. %) granite and then added different concentrations of (Fe) iron metal powders (5, 10,15and20) wt. % as reinforcements. The results show, as the metallic particulates (Fe) content increased, the linear attenuation coefficients will increase too.

3].Objective of research / Proposed Hypothesis :

1) Measuring the different polymers alloy through this technique gamma energies 123kev to 133kev.
2) To report the innovative findings beneficial for human begins.

4]. Methodology to be adopted:

Method of Observation:

First the gamma rays are passed through empty holder reaching the detector. The spectrum is obtained 1800 second using multichannel analyzer (MCA) which gives plot of channel number Vs counts. We select the interested peak which is smoothed for avoiding the random nature and obtain the peak gross area A_0 (The sum of spread counts which are coming under the peak) this is obtained in MCA the counts get spread over some energy range around the photo peak. This increases the accuracy of measured polymer elements kept in the holder and gamma rays are passed through it. The gamma rays passed through such polymer elements and interested peak gross area measured as A1,A2,…….A10 the other quantities measured in the experiment are interaction of gamma rays with polymer elements. This procedure is repeated for all the concentrations and all polymer elements we prepared for gamma energies from 123kev to 133kev.

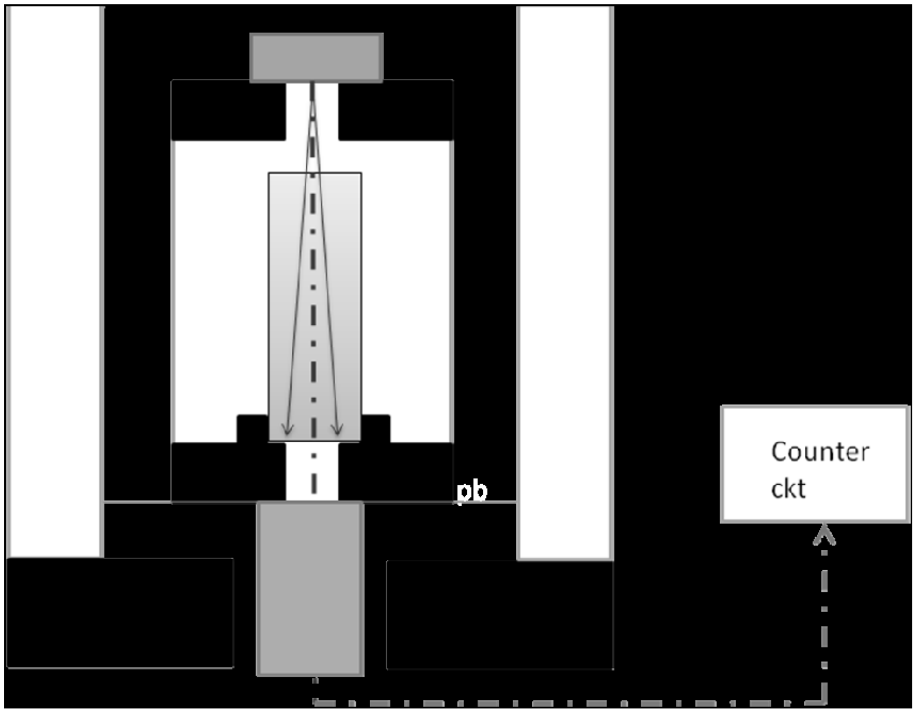

Figure: Experimental set up for measurement of gamma absorption coefficient for solution.

5]. Importance of study / society application:

The importance of the Polymers in other parameters like, The mass attenuation coefficients, half thickness values, electron cross section will also be studied.

We determined the gamma-ray attenuation characteristics of different polymers using transmission geometry using the thallium-activated sodium iodide detector NaI(Tl) scintillation detector and different radioactive sources in the energy range 123kev to 133kev.

Polymer testing and consultancy for plastics, additives with applications including aerospace, automotive, electronics, packaging and medical devices. Polymers are a highly diverse class of materials which are available in all fields of engineering from avionics through biomedical applications, drug delivery system, biosensor devices, tissue engineering, cosmetics etc. and the improvement and usage of these depends on polymer applications and data obtained through rigorous testing.

The applications of polymeric materials and their composites are still increasing rapidly due to their below average cost and ease of manufacture. When considering a polymer application, understanding how a material behaves over time allows us to assess its potential application and use. We can provide failure analysis of polymers and plastics and identify design faults or molding issues.

Our expertise can be applied to simple packaging films all the way through to advanced aerospace materials, and can be used as part of complex litigation cases. Polymeric materials tested include raw materials, polymer compounds, foams, structural adhesives and composites, fillers, fibers, films, membranes, emulsions, coatings, rubbers, sealing materials, adhesive resins, solvents, inks and pigments. Also can be used as a radiation protecting materials in different application as fallows.

- In aircraft, aerospace, and sports equipment
- Printed circuit board substrates
- 3D printing plastics
- Polymers in holography
- Biopolymers in molecular recognition
- Polymers in bulletproof vests and fire-resistant jackets
- Organic polymer flocculants in water purification
- Green Chemicals: Polymers and Biopolymers

- Polymeric Biomolecules
- Monomeric Units
- Renewable Biomass Sources

6]. Research Plan:

The tentative scheme of present research work will be as follows:

Sr. No.	Academic Year	Year wise Plan
1	2019-2020	* Review of literature and Data Collection • Study of related literature • Submitting first six monthly report • Problem formulation • First phase of experimental work (Synthesis of polymer elements) • Submitting six monthly repot • Attending conference on related work
2	2020-2021	• Second phase of practical work (Characterization of polymer elements) • Submitting third six monthly report • Statistical analysis of data • Publication of work in Physics Journals • Submitting fourth six month report
3	2021-2022	• Third phase of practical work • Submitting fifth six monthly report • Attending conference on related work • Publication of work in Physics Journals • Submitting Sixth six month report • Submitting synopsis to SRTMUN, Nanded. • Submission of thesis

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Research Guide

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